HAZARD CONTROL PLAN Renewal Cover Sheet

LANSCE Division

Title of Hazard Control Plan:
Operation of Automated Liquid Nitrogen Filling System in MPF-29

Hazard Control Plan Identification Number: LANSCE-3 HCP-09

Brief Description of Work:
This Hazard Control Plan (HCP) outlines hazards and safe procedures for operation of the liquid nitrogen (LN2) filling systems used on WNR Flight Paths 60 Right (4FP60R) and 30 Right (4FP30R) located at TA-53, MPF-29, Rooms 100 and 101. Flight Path 60 Right includes an automated liquid nitrogen filling system, and Flight Path 30 Right uses either manual filling or an automated filling system, and occasionally continuous-flow of LN2.

Reviewer of the Plan (This HCP and the operating experience have been reviewed and no significant modifications are needed at this time)**:**

Ronald O Nelson	**Staff Member**	Ronald O Nelson	9/9/03
Name	Title	Signature	Date

Initial Risk Estimate: ❒ Minimal ❒ Low ■ Moderate ❒ High

Applicable Safety Permits Required to Perform Work: None

Residual Risk Estimate: ❒ Minimal ■ Low ❒ Moderate

Work Authorization:

BRUCE TAKALA	DGL	Bruce Takala	9-9-03
Name	Title	Signature	Date

Next Authorization Review Date: 9/8/2004

HAZARD CONTROL PLAN Renewal Cover Sheet

LANSCE Division

Title of Hazard Control Plan:
Operation of Automated Liquid Nitrogen Filling System in MPF-29

Hazard Control Plan Identification Number: LANSCE-3 HCP 9

Brief Description of Work:
This Hazard Control Plan (HCP) outlines hazards and safe procedures for operation of the liquid nitrogen (LN2) filling systems used on WNR Flight Paths 60 Right (4FP60R) and 30 Right (4FP30R) located at TA-53, MPF-29, Rooms 100 and 101.

Reviewer of the Plan (This HCP and the operating experience have been reviewed and no significant modifications are needed at this time)**:**

Matt Devlin	Reviewer		8/30/02
Name	Title	Signature	Date

Initial Risk Estimate: Moderate

Residual Risk Estimate: Low

Work Authorization:

Bruce Takala	DGL	Bruce Takala	8-30-02
Name	Title	Signature	Date

Next Authorization Review Date: 08/16/2003

LANSCE Division
Hazard Control Plan Cover Sheet

Operation of Automated Liquid Nitrogen Filling System in MPF-29		
LANSCE-3 HCP-9	**Revision:** 1	**Date:** 2/10/2000
Location of Work: TA-53/ MPF-29		**Group:** LANSCE-3
Author:	**Signature**	**Date**
Ron O Nelson (LANSCE-3)	Ron O. Nelson	~~2/10/2000~~ 5/30/00

Initial Risk Level: medium		
REVIEW/APPROVAL		
Reviewed by:		
Bruce Takala (LANSCE-3)	Bruce Takala	5-30-00
(ESH-5)		
Dory Ryan (LANSCE-FM)	Dory L Ryan	6-20-00

Residual Risk Level: low		
Approved by:		
Steve Wender (LANSCE-3 GL)		6/30/00
Next Authorization Review Date: ~~2/10/2001~~ 06/30/01		

Operation of Automated Liquid Nitrogen Filling System in MPF-29

Work definition:
This Hazard Control Plan (HCP) outlines hazards and safe procedures for operation of the liquid nitrogen (LN2) filling systems used on WNR Flight Paths 60 Right (4FP60R) and 30 Right (4FP30R) located at TA-53, MPF-29, Rooms 100 and 101. Flight Path 60 Right includes an automated liquid nitrogen filling system, and Flight Path 30 Right uses either manual filling or an automated filling system, and occasionally continuous-flow of LN2. The purpose of the automated liquid nitrogen filling system is to keep as many as 35 high-purity germanium (HPGe) detectors of the GEANIE spectrometer continuously cooled to liquid nitrogen temperatures. The detector dewars have a capacity of 1.2 l of LN2 with a nominal holding time of 24 hours. Neutron damage to the HPGe detectors greatly degrades their energy resolution if they are allowed to warm up. Repair of the neutron damage requires a time-consuming annealing process. Loss of use of all or part of the array for an extended period of time will result if the automatic filling fails and is not corrected for more than 8 to 12 hours, assuming an automatic filling schedule of every 8 hours. The purpose of the manual filling system in Room 101 (Flight Path 30 Right) is to keep up to six individual Ge detector dewars filled, for the same reasons as listed above; these typically have 4-5 l capacity and nominal holding times of 5 days. In addition, an array of six SiLi detectors used in the University of Pittsburgh "ICEBALL II" array are sometimes used on Flight Path 30 Right, and these detectors use a flow-regulated continuous flow of LN2 to maintain their operational temperature. The LN2 system is sometimes used with other detectors in both rooms 100 and 101.

Figure 1 shows the locations of the dewars, the spectrometer cave, and the oxygen level monitors in room 100. The 2000 l supply dewar is located outside of the southwest corner of building MPF-29. The two 240 l supply dewars are located in the southwest corner of the experimental cave in room 100 of MPF-29. The 2000 l dewar is used to fill the 240 l dewars when they are low on LN2. The 240 l dewars are used to supply LN2 to the detector dewars. A computer controls and monitors the filling operations. The computer is connected to two interface boxes mounted on the west wall inside the experimental cave in room 100. The interfaces consist of DC power supplies, OPTO-22 controller cards, and time-out relays. The time-out relays serve as a safeguard to stop any filling operation which lasts more than a preset time. As such, the relays act as a safety mechanism to avoid spilling excessive amounts of LN2 into the room in the event of a hose or joint failure, or dumping of large quantities of LN2 through the exhaust should the computer fail. A battery-powered autodialer will call responsible personnel in the event of a power failure, or failure to fill one or more of the detectors on schedule. The entire filling system is powered by an uninterruptible power supply to keep the system running despite power outages of several hours duration. The interface boxes have switches to allow manual filling of the detectors if necessary. The exhaust is vented outside the building to avoid any buildup of nitrogen that could potentially cause an oxygen deficiency in the room. Figure 2 shows a schematic layout of the 3 supply dewars, the detector dewar supply and exhaust manifolds for the LN2 system in room 100, and the LN2 feed line for room 101.

Figure 3 shows the locations of the dewars, the spectrometer cave, and the oxygen level monitors in room 101. One 240 l supply dewar is located in the experimental cave in room 101 of MPF-29 when the SiLi detectors are in use. The 2000 l dewar is used to fill the HPGe dewars and the 240

l dewar when they are low on LN2. The 240 l dewar is used to supply LN2 to the SiLi detectors. The exhaust for the SiLi detectors is vented outside the building to avoid any buildup of nitrogen that could potentially cause an oxygen deficiency in the room.

Two oxygen level monitors with alarms are located in building MPF-29. One is located on the west wall in the 60R experimental cave in room 100. The other is located on the west wall of room 101. These alarms warn personnel in the building of a low oxygen level that requires evacuation of the building. LANSCE-3 is responsible for maintenance and records of the oxygen level monitors. The monitors and alarms should be tested every 8 weeks and repaired or replaced if not working properly.

Figure 1

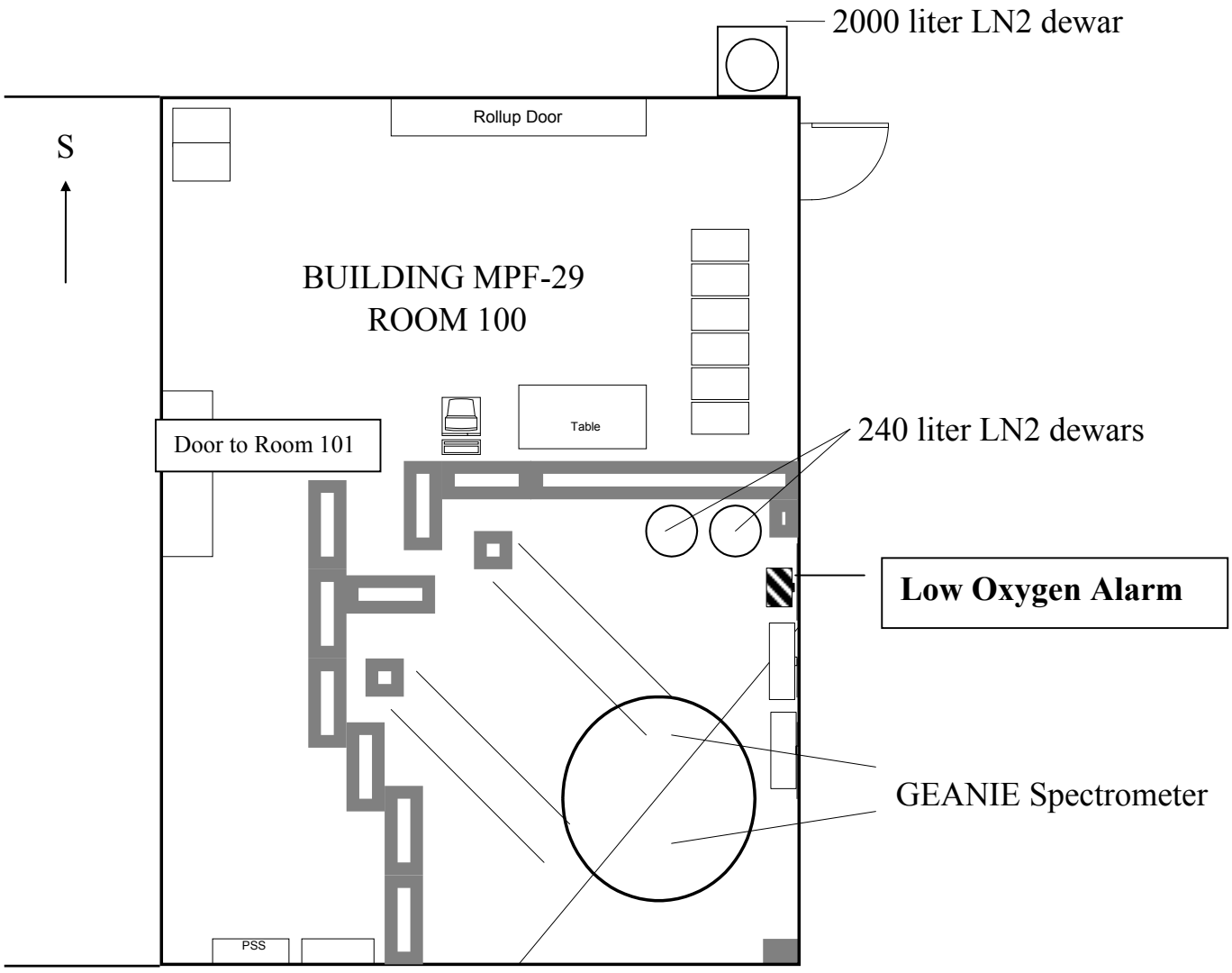
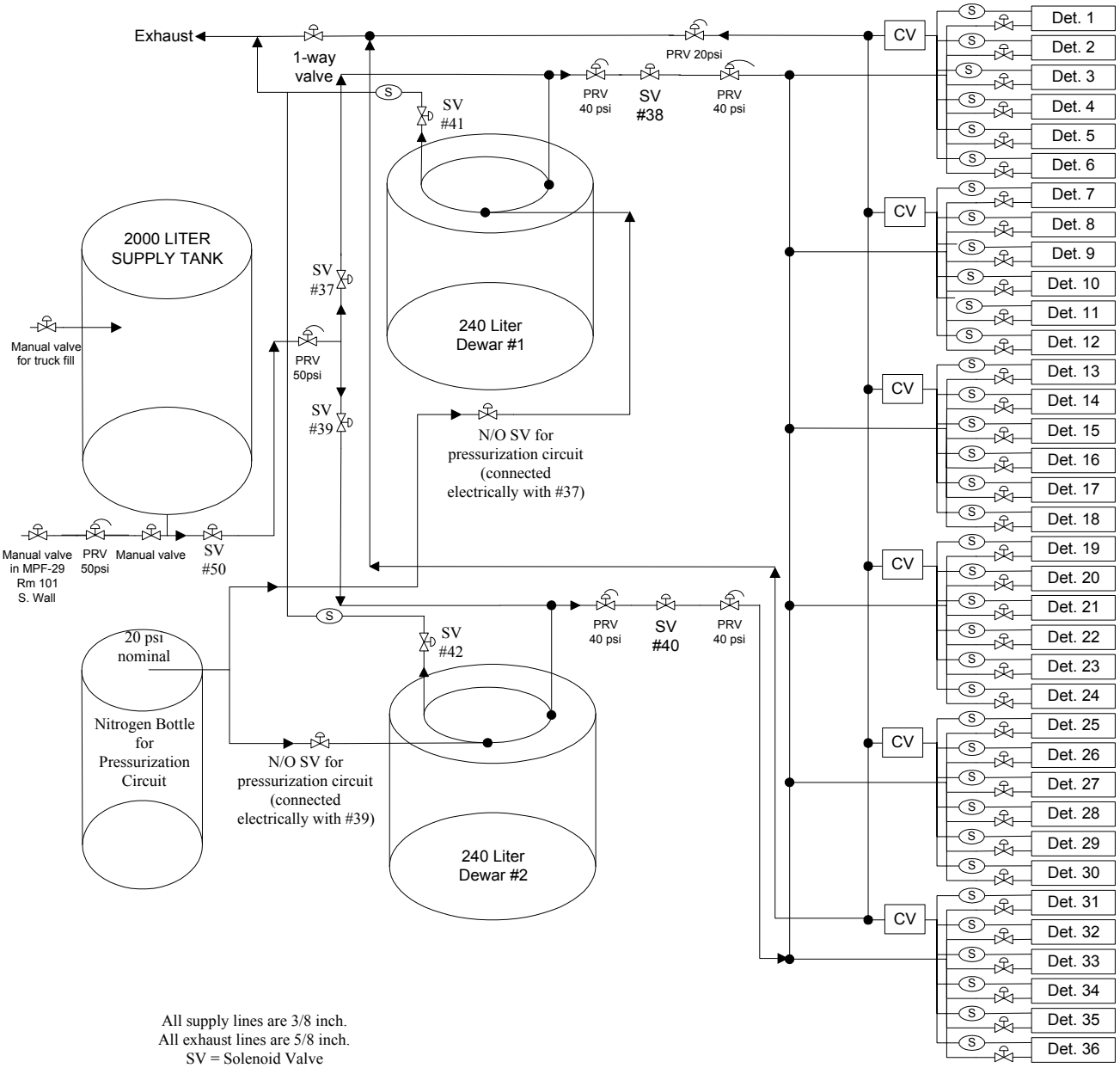


Figure 2

WNR 4FP60R LN2 FILL SYSTEM

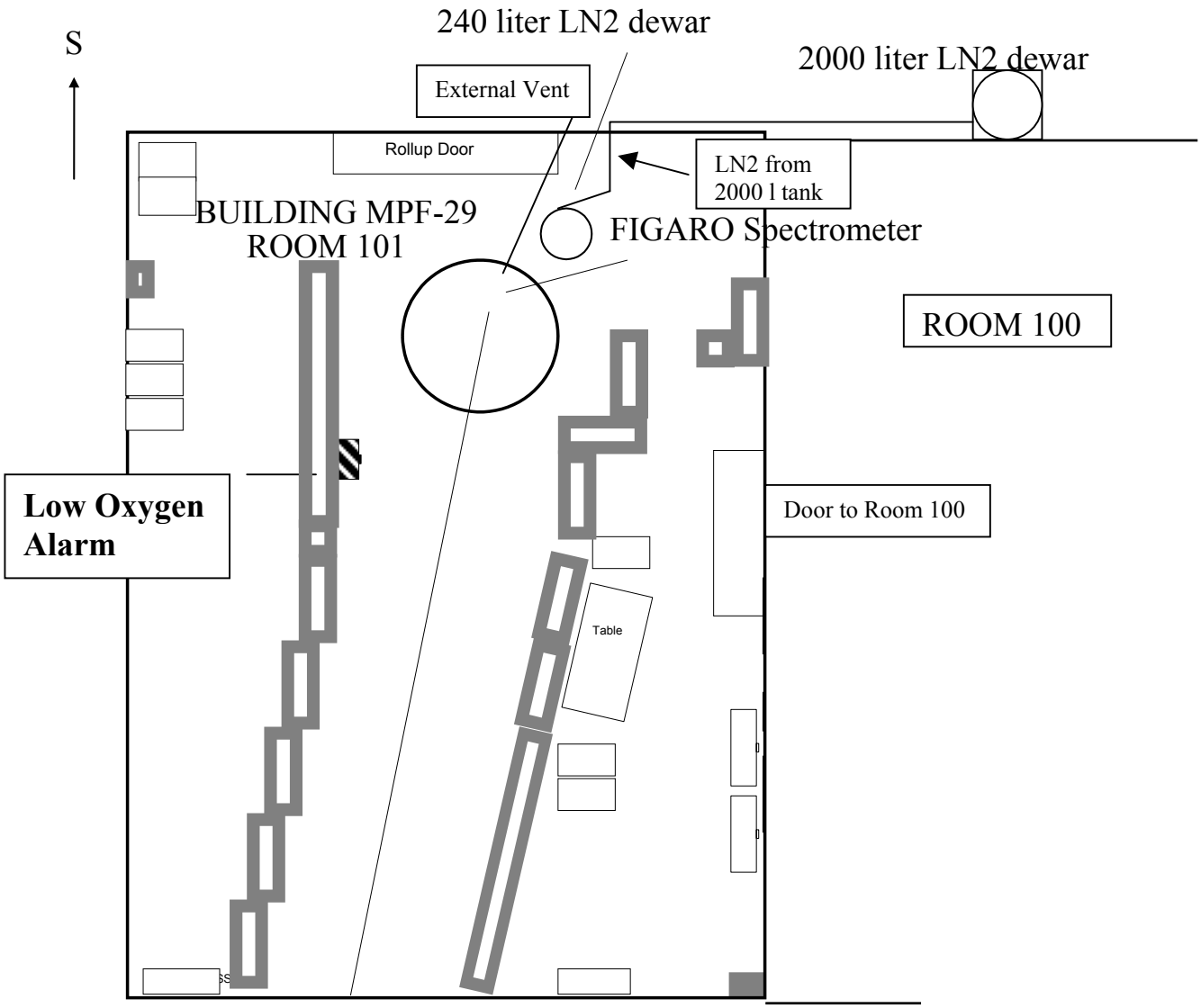
Date: 2/29/96
R. Corrow
Revised 11/10/99
R. Nelson (LANSCE-3)



All supply lines are 3/8 inch.
All exhaust lines are 5/8 inch.
SV = Solenoid Valve
N/O = normally open
PRV = Pressure Relief Valve
CV = Check Valve
S = Sensor
Detectors have 1.2 l dewars

All detector dewars have 10psi PRV's
All detector sensors are followed by check valves

Figure 3



Ordinarily the LN2 filling system should require little attention other than periodic maintenance to check for leaks or control electronics and computer problems. The most common work involves thawing and clearing water ice buildup from inside the filling nozzles in the detector dewars. The control computer, autodialer, and low oxygen level alarms should alert users of most problems that may arise.

Potential hazards: Cryogenic Liquids and Overpressures

Hazards exist with the use of cryogenic liquids. One of the main hazards arises from overpressures that may occur if the liquid evaporates to gas. The volume ratio between the gas at room temperature and the cryogenic liquid is about 1000. As a result, unless preventive measures

are taken, substantial pressures will occur with cryogenic fluids confined to small, fixed, unvented volumes. Overpressures are also possible if a blockage occurs in one of the tubes that exhausts the nitrogen. Blockages can occur in tubes at low temperature if condensables such as water vapor enter the system.

Nitrogen gas from LN2 contains no oxygen and can cause asphyxiation by diluting the air. If the oxygen concentration is below 8%, unconsciousness occurs in less than a minute. Depending on the room volume, modest quantities of cryogenic liquid can create an oxygen deficiency hazard if vaporized. Cold N2 is especially dangerous because it can settle near floor level.

Cryogenic liquids create hazards because of their low temperatures. Contact with the liquids, their vapors, and anything cooled to cryogenic temperatures can freeze living tissue; eyes are particularly vulnerable. Freezing can also cause breakage and loss of strength of materials which are not suited for cryogenic use such as most plastic or rubber.

If air condenses on a cold surface, the resulting liquid will contain 52% oxygen, since oxygen condenses at a slightly higher temperature than does nitrogen. Such liquid should be treated as liquid oxygen and not be allowed to contact combustible materials.

Cold surfaces will freeze water from the air, and over time build up ice. Ice can interfere with the operation of nearby mechanical devices (valves, relief devices, etc.) or cause shorting of electrical connections.

If other gases, particularly air, are allowed to leak into spaces containing LN2, they can condense and solidify, leading to plugged vent lines (possibly causing dangerously high pressure), plugs in other piping, interference with valve operation, erosion of valve seats and moving parts, and contamination of the LN2. Such contaminants will build up over time until they are removed by warming the system to temperatures above their boiling point.

Initial Risk Estimate:
The initial risk, based on the quantities of LN2 available, the hazards listed above, and the work to be performed, is estimated as "**medium**" per the LIR300-00-01 risk matrix.

Operational requirements:

LIR402-580-01.1 (*Cryogenic Fluids or Cryogens*), **LIR402-1200-01.0** *(Pressure, Vacuum, and Cryogenic Systems*), **TB 1402** (*Compressed Gases*), and **TB 1404** (*Inspection and Test of Pressure Systems*) describe requirements and procedures for designing, constructing, operating, and maintaining cryogenic and compressed gas systems, such as the one described here. These documents have been considered in writing this HCP.

Controls:

Personnel protective equipment (PPE):

Insulated gloves, and a face shield must be worn whenever work is being performed on components of the system that contain or might contain LN2. Safety glasses must be worn in the

experimental cave during dewar and Ge detector dewar filling as a precaution against exposure of the eyes to LN2 in the event of an unexpected leak occurring in the system.

Engineering controls:

Overpressure relief valves are installed at strategic locations in the system so there are no unvented volumes.

Ordinary boil-off gases are vented outside of the building. Low O_2 alarms are located in the building to warn occupants of oxygen deficient conditions. If an alarm is heard before or upon entering the building, personnel should leave the area immediately and call one of the contacts listed in the emergency procedures below

Pressure relief valves and vents are positioned and/or shielded to prevent exposure to personnel in the event of a release of LN2. Special plastic tubing (Tygothane) is used for all flexible tubing connections in the system to mitigate the potential for breakage and leaks. Only Tygothane tubing should be used when making repairs or modifications. Although handling of LN2 is not expected in routine operation, standard laboratory practice should be followed for handling cryogenic liquids when using hand dewars or conducting filling tests. Standard practice includes use of gloves and safety glasses when dealing with exposed LN2.

The majority of the LN2 system is insulated to prevent the buildup of liquid oxygen. The manifolds are located away from combustible materials. The majority of the time this system, except for the internal parts of the dewars, is at room temperature, so hazards from liquid oxygen are minimal.

To minimize ice buildup the system is well insulated with high-quality foam insulation. Because most of the system is at room temperature, large accumulations of ice should not occur. Permanent buildup of ice indicates a problem with a dewar or valve and should be investigated immediately.

The system is designed to maintain a flow of dry nitrogen through the exhaust and has valves to prevent moisture or air from entering the system. The fact that the filling system is warmed most of the time minimizes problems with buildup of unwanted substances.

Inspection Requirements:

All relief valves, vents, and connecting piping will be visually inspected annually for any defects or improper operation. The LN2 dewars will be visually inspected annually for loose fittings, signs of corrosion or damage. The two oxygen level monitors in MPF-29 will be inspected every 8 weeks for proper operation.

Required Knowledge Skills & Abilities:

People who work on or operate the LN2 system must have cryogen training and compressed gas training. A list of authorized workers is attached. On the job training in the operation of the system is also required before a person may operate or work in the LN2 system.

Wastes:

No hazardous or radioactive waste is generated during the normal operation of this system.

Residual Risk:

The residual risk of operating or working on this system with implementation of the above PPE, engineering and administrative controls is estimated as "**low**".

Emergency Procedures:

A cryogenic emergency is the unexpected release of more than 30 l of LN2 in either the experimental cave or building MPF-29, or the activation of the oxygen monitor alarms by an oxygen deficient condition in the building.

In the event of a low oxygen alarm or catastrophic failure of any of the dewars:

(1) **Evacuate the entire building**. If possible, during the evacuation, the "open" switches of the large rollup doors in the south wall of building 29 should be energized to provide rapid ventilation of the building. Personnel in MPF-29 room 100 should proceed outside around the building to the pedestrian door in the east side of MPF-29, and call out for anyone in room 101 (east side of MPF-29) to evacuate the building.

(2) **Proceed to the vehicle entrance gate (muster area) at the top of the WNR driveway**.

(3) **Call 911** (or pull a fire alarm box) **to summon help using a phone in building 406 or 407.** Request an ambulance. STAY ON THE LINE until the dispatcher has confirmed your location and the nature of the accident. If a person has collapsed within the building during a cryogenic emergency, **do not enter the building to attempt a rescue.** Call 911 and request assistance for a victim incapacitated in an oxygen depleted environment. Send someone to meet the emergency vehicle and direct to where it is needed.

Notify one of the contacts listed below:

Ron Nelson	667-7107, 984-8165, 104-2191
Matt Devlin	665-0421, 663-1094, 104-5776
Steve Wender	667-1344, 983-3634, 104-2185
Bruce Takala	665-2029, 104-8827
LANSCE-3 Group Office	667-5377
CCR	667-5729

<u>Re-entering MPF-29 after Evacuation for a Cryogenic Emergency:</u>

If MPF-29 has been evacuated because of a large release of LN2, extra care must be taken before re-entry.

1. Call Industrial Hygiene and request oxygen level monitoring.
2. Have Industrial Hygiene monitor the room before personnel are allowed back in.

Frostbite and Tissue Freezing:

Remove any clothing that may restrict circulation in the frozen area.

DO NOT ATTEMPT TREATMENT. If part of the feet are frozen, DO NOT WALK. Wait for emergency personnel to arrive and administer aid.

Calculation of "safe" volume of LN2 for Building MPF-29:

The volume of building MPF-29 room 100 is approximately 390 m^3 (18' high X 24' X 33' = 14000 ft^3 X $(0.3048m/ft)^3$) = 396 m^3). According to LIR402-580-01.1, the ES&H manual the safe working volume of LN2 is V_S (liters) = V_W (m^3)/14 = 390/14 = 27.9. An accidental release of this volume of cryogen is expected to be noticeable to workers in the room, and is cause for evacuation. Room 101 has a similar volume. Because the air conditioning systems are interconnected the entire building should be evacuated in the event of a large spill.

Change Control Process:

This document must be reviewed at least annually. The latest version will be available on the LANSCE-3 web site, in the LANSCE-3 group office, and copies posted at the entrances to MPF-29.

Attachment

The installation and operation of the automated liquid nitrogen filling system is the responsibility of personnel from LANSCE-3. The LANSCE-3 Group Office is located at TA-53, MPF-1, Room C138, telephone number (505) 667-5377.

The designated staff member is responsible for safe operation of WNR Flight Path 60R and maintenance of this HCP. The staff member will be the primary contact for users of the flight path and safety personnel. Additional personnel from LANSCE-3, P-23 and external collaborators will also be responsible for maintenance and operation of the automated liquid nitrogen filling system. ALL users of Flight Path 60R, as well as visitors, are responsible for following the procedures outlined in this HCP.

A list of associated personnel is given below:

Staff members:

Ron Nelson	667-7107, 984-8165, pager 104-2191
Matt Devlin	665-0421, 663-1094, pager 104-5776

Technicians:

Gregg Chaparro	665-2861, pager 104-8734
Lloyd Hunt	665-6300, pager 104-8738
Art Bridge	665-4124, pager 104-2469

Attachment

Authorized LN2 System Workers

By signing the following people indicate that they have received the required training and are authorized to work on and operate the LN2 filling system described in this HCP.

Ron Nelson (LANSCE-3) 667-7107, 984-8165, 104-2191 (digital) _____

Gregg Chaparro (LANSCE-3) 665-2861, 104-8734/104-3023 (digital) _____

Lloyd Hunt (LANSCE-3) 665-6300, 104-8738 (digital) _____

Dick Stein (LANSCE-3) 665-0230, 672-9058, 104-3709 _____

Matt Devlin (LANSCE-3) 665-0421, 663-1094, 104-5776 (digital) _____

Nikolaos Fotiades (LANSCE-3) 665-0589, 663-1070, 104-1934 (digital) _____

Robert Haight (LANSCE-3) 667-2829, 104-6842 (digital) _____

Luca Zanini (LANSCE-3) 665-3019, 104-5328 (digital) _____